REMARKS

## Introduction

This application has been reviewed in light of the Office Action mailed on October 1, 2009. Claims 21-23, 26-28, 30, 32, 34, and 42-49 remain pending in this application. Claim 21, the sole independent claim, has been amended to define still more clearly what Applicants regard as their invention; these changes have been made for the purposes of clarification only, and no change in scope of the claims is either intended or believed to be effected by the changes.

## The rejections under 35 U.S.C. § 112

Claim 21 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The claims have been carefully reviewed and amended as deemed necessary to ensure that they conform fully to the requirements of Section 112, second paragraph, with special attention to the points raised in paragraph 4 of the Office Action. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

## The rejections under 35 U.S.C. § 103

• Claims 21-23, 26, 27, 32, 42-46, and 48 were rejected under 35 U.S.C. § 103(a) as being obvious from U.S. Patent Application Publication No. US 2004/0001661 A1 to Iwaki in view of the publication by Maruo entitled "Three-Dimensional Microfabrication with Two-Photon-Absorbed Photopolymerization," Optics Letters, vol. 22, no. 2, January 1997, pp. 132-134

(hereinafter "Maruo").

• Claims 28 and 30 were rejected under 35 U.S.C. § 103(a) as being obvious from Iwaki in view of Maruo and further in view of U.S. Patent No. 6,684,007 to Yoshimura.

• Claim 34 was rejected under 35 U.S.C. § 103(a) as being obvious from Iwaki in view of Maruo and as evidenced by U.S. Patent No. 5,255,070 to Pollak.

• Claims 47 and 49 were rejected under 35 U.S.C. § 103(a) as being obvious from Iwaki in view of Maruo and further in view of the publication by Cumpston et al. entitled "Two-photon polymerization initiators for three-dimensional optical data storage and microfabrication", Nature, vol. 398, March 1999, pp. 51-54 (hereinafter Cumpston).

Applicants submit that independent method claim 21, together with the claims dependent therefrom, are patentably distinct from the cited references for at least the following reasons.

Claim 21 is directed to a method for producing a printed circuit board element. The method includes mounting at least one optoelectronic component to a substrate. The method also includes subsequently applying to the substrate an optical layer, comprised of an optical material changing its refractive index under photon irradiation, while embedding the optoelectronic component in the optical layer.

The method also includes thereafter determining, by an optical vision unit, a position of the optoelectronic component embedded in the optical layer. The optical vision unit subsequently controls a radiation unit including a lens system to displace a focal area of an emitted laser beam, in a plane of the printed circuit board element, and adjusts the focal area also in terms of a depth within the optical layer.

Thereafter, the method includes producing an optical waveguide structure adjoining the optoelectronic component within the optical layer by photon irradiation, the optical

waveguide structure being surrounded by the remaining optical layer.

By using the respective optoelectronic component as a reference element according to the features of amended claim 21, the optical waveguide can, thus, be designed as desired within the optical layer, for instance, as a simple, straight optical waveguide connection or as a waveguide structure having branches or similar structures or, in particular, even as a three-dimensional structure. The cross-sectional dimensions of the thus-structured optical waveguide can, for instance, be on the order of some micrometers, possible cross sections of thus-structured optical waveguides including, for instance, elliptical to rectangular cross sections. The exact shape can be determined by the photon beam and its focus control. See the present specification at, e.g., page 4, lines 7-28.[1]

As noted above, independent claim 21, as well as a number of dependent claims, stand rejected under 35 U.S.C. § 103(a) based upon a combination of Iwaki and Maruo.

However, Applicants submit that the pending claims, corrected for the formal deficiencies as noted above, are in condition for allowance, as not even a combination of these prior art references (even assuming such a combination would be permissible) would render the claimed subject matter obvious.

In the Office Action, the Examiner concedes that Iwaki does not "directly" illustrate the sequence in which the individual steps of the claimed method for producing a printed circuit board element are performed.

In short, the claimed method is based on *first*, mounting an optoelectronic component to a substrate; *second* applying to the substrate an optical layer; *third*, determining, by an optical

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[1]It is of course to be understood that the references to various portions of the present application are by way of illustration and example only, and that the claims are not limited by the details shown in the portions referred to.

vision unit, a position of the optoelectronic component; *fourth*, controlling, by said optical vision unit, a radiation unit including a lens system to three dimensionally adjust the focal area; and *fifth*, producing an optical waveguide structure adjoining the optoelectronic component by photon irradiation within the optical layer.

Iwaki fails to disclose an optical vision unit for determining a position of a previously mounted optoelectronic component, whereafter the optical waveguide structure adjoining the optoelectronic component is "written" into the optical layer.

On the other hand, Maruo, cited in this regard, is only remotely related to the present method and certainly cannot suggest the specific positioning and focusing of the laser beam for writing an optical waveguide structure to previously mounted components according to the invention.

Maruo shows in Fig. 2 an optical system for fabricating 3D microstructures via photopolymerization using laser radiation from a Ti:Sapphire laser source focused in the sample by a lense system. A computer is provided for controlling the movement of a stage supporting the sample (cf. p. 133, 2nd para.).

According to the Examiner, a vision unit is given by a CCD camera in connection with a monitor. However, the CCD camera is merely used for taking images of the structures made up by solidified resin which can then be observed on the monitor (cf. for instance the images from Fig. 3). As can be clearly inferred from Fig. 2, the scanning of the sample under computer control is entirely independent from the CCD camera (and the monitor) which would thus be inadequate for controlling the radiation unit or the movement of the stage, respectively.

Therefore, the CCD-camera of Maruo and the use thereof is completely different from the

claimed vision and positioning unit which serves for identifying first the position of an optoelectronic component - such a component being not at all involved in the system according to Maruo - and then controlling, by said optical vision unit, the radiation unit to adjust the focal area for precisely adjoining the waveguide to the optoelectronic component.

Thus, even the combined teachings of Iwaki and Maruo fail to teach or suggest the features of present independent claim 21.

However, the inventive concept of the present method also lies in the claimed sequence of steps, which cannot be suggested even by a combination of Iwaki and Maruo. In this respect, the Examiner contends that an obvious "reordering" of the sequence taught by Iwaki leads to the claimed subject-matter.

According to the Examiner, it would be obvious for producing a "simple" circuit board element as shown in Fig. 1 (without recesses filled with light-transmitting resin as of Fig. 2) to sequentially perform (a) the step of Fig. 7D (mounting an optoelectronic component 103 on substrate 119), (b) the step shown in Fig. 7B (applying an optical layer 106), and (c) the step of Fig. 7A (producing, by photon irradiation, a waveguide structure 105 in the optical layer 106).

However, such a reversed order of the steps illustrated in Figs. 7A to 7I lacks any basis in Iwaki and is evidently the result of hindsight (MPEP 2142: "...impermissible hindsight must be avoided..."). In contrast to the Examiner's assertion, the chronological sequence is strictly emphasized in the specification of Iwaki ("Firstly, as shown in Fig. 7A, [...]; Next, as shown in FIG. 7B, [...]", cf. para. [0069] and [0070] of Iwaki).

Exchanging the steps according to Fig. 7A and 7B, for instance, would not yield a viable result. In para. [0070] and [0071] of Iwaki it is explained that through hole or recess 115 is

formed at a desired position of the waveguide layer 104 so as to expose an end face of the optical waveguide core portion 105. This, however, requires the waveguide core portion 105 to be already formed and it thus would not be practical to perform the step of Fig. 7B before the step of Fig. 7A. Applicants note that:

> ... [R]ejections on obviousness cannot be sustained by mere conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. MPEP 2141.III, quoting *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 82 USPQ2d 1385, 1396 (2007). (Emphasis added.)

The present invention involves a significant advantage over the method of Iwaki, as by mounting the optoelectronic component before writing the waveguide structure, the positioning of the optoelectronic component - which in production is only possible with limited preciseness - is not so crucial (cf. present specification, p. 3, para. 5). On the other hand, according to Iwaki the optoelectronic elements have to be adjoined to the previously formed waveguide with very high accuracy so as to establish the required connection.

The present invention therefore trades a somewhat more sophisticated set-up (using a vision and positioning system for adjoining the waveguide to the embedded components) against lesser demands involved with mounting the components. The latter has been identified by Applicants to be the limiting factor in producing more complex, free-form 3D waveguide structures linking optoelectronic components, which is made feasible with the claimed method.

If, assuming *arguendo*, it is assumed for the method taught by Iwaki that the optoelectronic components 101, 103 are mounted on substrate 119 before the waveguide core layer 105 is formed in optical layer 106, as indicated by the Examiner, such a - hypothetical - exchange in steps 7B to 7D would not increase the accuracy in positioning and linking the

optical waveguide and the optoelectronic components, if the desired properties of the circuit board of Iwaki are to be maintained.

The waveguide core layer 105 is formed in layer 104 which is distinct and at first separate from the substrate119. Therefore, upon lamination of film 104 with substrate 119 - regardless of whether the components 101, 103 have been mounted before the waveguide core layer 105 is formed in layer 106 or not - the waveguide core layer 106 still needs to be exactly linked with the components 101, 103.

Iwaki nowhere hints at a process, wherein the components are directly embedded in the optical waveguide film, and the waveguide core portion is only formed afterwards. If such a sequence were contemplated in Iwaki - it is not - the process would be very different, as in this case neither forming the through hole 115 filled with light-transmitting resin 109, nor the lamination step in Fig. 7C would be necessary.

In case press molding is used for forming the optical waveguide of Iwaki - which is the only embodiment explained in detail - it would not be technically feasible to embed the components before forming the waveguide core layer, which again is a sign for the non-obviousness of the present method.

In any case, it would be required to install a vision unit for determining the position of the components and, under control of the vision unit, adjoining the waveguide to the previously mounted components, which, however, cannot be found in Iwaki.

As Iwaki relies upon a method where the components are mounted after the waveguide has been produced, the use of a vision and positioning unit would be useless for the disclosed technique. Accordingly, a person having ordinary skill in the art had no incentive to search the field for a vision unit according to the invention and would therefore not consider any

such prior art.

However, even if assuming *arguendo* a person having ordinary skill in the art would combine the teachings of, for example, Maruo with the method of Iwaki, that person would not arrive at the claimed subject matter, as the CCD camera and the monitor disclosed therein would not at all be suitable in performing the present method.

Hence, the present method is not only novel, but moreover non-obvious and therefore patentable.

Accordingly, amended claim 21 is seen to be clearly allowable over the Iwaki and Maruo, whether considered separately or in any permissible combination (if any).

The dependent claims

The other claims in this application are each dependent from independent claim 21 discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

## Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Respectfully submitted,

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